CLAIMS:

What is claimed is:

1. A method for selectively depositing silicon oxide onto a substrate, the method comprising the steps of:

providing a substrate having at least one exposed region of silicon and at least one exposed region of silicon nitride and/or comprising at least one exposed silicon region of one type of conductivity and at least one exposed silicon region of a different type conductivity;

delivering, via a linear injector, ozone and tetraethylorthosilicate into contact with the substrate and with each other, wherein the delivery of the ozone is pulsed on and off; and

reacting the ozone and tetraethylorthosilicate in contact with the substrate to selectively deposit silicon oxide onto the substrate.

2. Method of claim 1 wherein the ozone is pulsed for 1-4 second intervals.

3. Method of claim 1 wherein the ozone is pulsed for 1 second intervals.

4. A method for selectively depositing silicon oxide onto a substrate, the method comprising the steps of:

providing a substrate having at least one exposed region of silicon and at least one exposed region of silicon nitride and/or comprising at least one exposed silicon region of one type of conductivity and at least one exposed silicon region of a different type conductivity;

delivering, via a linear injector, ozone and tetraethylorthosilicate into contact with the substrate and with each other, wherein the delivery of the ozone is pulsed on and off; and

reacting the ozone and tetraethylorthosilicate in contact with the substrate to selectively deposit silicon oxide onto the substrate,

wherein the reaction occurs at a temperature up to about 500° C and a pressure of at least about 10 torr.

5. The method of Claim 4, wherein the reaction occurs at a temperature up to about 400° C.

6. The method of Claim 4, wherein the reaction occurs at a pressure of at least about 300 torr.

7. The method of claim 4 wherein the ozone is pulsed at intervals between 1-4 seconds.

8. The method of claim 4 wherein the ozone is pulsed at intervals of about 1 second.

9. A method for selectively depositing silicon oxide onto a substrate, the method comprising the steps of:

providing a substrate having at least one exposed region of silicon and at least one exposed region of silicon nitride and/or comprising at least one exposed silicon region of one type of conductivity and at least one exposed silicon region of a different type conductivity;

delivering, via a linear injector, ozone and tetraethylorthosilicate into contact with the substrate and with each other, wherein the delivery of the ozone and the delivery of the tetraethylorthosilicate are pulsed on and off alternately; and

reacting the ozone and tetraethylorthosilicate in contact with the substrate to selectively deposit silicon oxide onto the substrate.

10. The method of claim 9 wherein the alternate pulse durations are between about 1 to about 4 seconds.

11. The method of claim 9 wherein the alternate pulse durations are about 2 seconds.

12. A method for selectively depositing silicon oxide onto a substrate, the method comprising the steps of:

providing a substrate having at least one exposed region of silicon and at least one exposed region of silicon nitride and/or comprising at least one exposed silicon region of one type of conductivity and at least one exposed silicon region of a different type conductivity;

delivering, via a linear injector, ozone and tetraethylorthosilicate into contact with the substrate and with each other, wherein the delivery of the ozone and the delivery of the tetraethylorthosilicate are pulsed on and off alternately; and

reacting the ozone and tetraethylorthosilicate in contact with the substrate to selectively deposit silicon oxide onto the substrate,

wherein the reaction occurs at a temperature up to about 500° C and a pressure of at least about 10 torr.

13. The method of Claim 12 wherein the reaction occurs at a temperature up to about 400° C.

14. The method of Claim 12 wherein the reaction occurs at a pressure of at least about 300 torr.

15. The method of claim 12 wherein the alternate pulse duration is between about 1 to about 4 seconds.

16. The method of claim 12 wherein the alternate pulse duration is about 2 seconds.

17. A semiconductor processing method of forming spacers of variable thickness, the method comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first conductive region comprising either P-type silicon or non-doped silicon and at least one second conductive region, provided that:

(1) when the first conductive region comprises P-type silicon, then the second conductive region comprises either non-doped silicon or N-type silicon; and,

(2) when the first conductive region comprises non-doped silicon, then the second conductive region comprises N-type silicon;

decomposing tetraethylorthosilicate with ozone to selectively deposit silicon oxide over the silicon surface and over both the first conductive region and the second conductive region, wherein delivery of the ozone is pulsed on and off whereby a greater thickness of silicon oxide is deposited on the first conductive region than on the second conductive region and delivery of the ozone and the tetraethylorthosilicate is via a linear injector; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second conductive regions provides a layer of variable thickness around the first conductive region and the second conductive region.

18. The method of claim 17 wherein the pulse duration is between about 1 to about 4 seconds.

19. The method of claim 17 wherein the pulse duration is about 1 second.

20. A semiconductor processing method of forming spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first conductive region comprising either P-type silicon or non-doped silicon and at least one second conductive region, provided that:

(1) when the first conductive region comprises P-type silicon, then the second conductive region comprises either non-doped silicon or N-type silicon; and,

(2) when the first conductive region comprises non-doped silicon, then the second conductive region comprises N-type silicon;

contacting silicon-comprising substrate with ozone and tetraethylorthosilicate wherein delivery of the ozone is pulsed on and off whereby the first conductive region and the second conductive region are in intimate contact with the ozone and the tetraethylorthosilicate and delivery of the ozone and the tetraethylorthosilicate is via a linear injector;

reacting the ozone and the tetraethylorthosilicate at a temperature up to about 500° C and a pressure of at least about 10 torr to selectively deposit silicon oxide over the substrate surface and both the first conductive region and the second conductive region, whereby a greater thickness of silicon oxide is deposited on the first conductive region than on the second conductive region; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second

conductive regions provides a layer of variable thickness around the first conductive region and the second conductive region.

21. The method of Claim 20 wherein the reaction occurs at a temperature up to about 400°C.

22. The method of Claim 20 wherein the reaction occurs at a pressure of at least about 300 torr.

23. The method of Claim 20 wherein the pulse duration is between 1-4 seconds.

24. The method of claim 20 wherein the pulse duration is about 1 second.

25. A semiconductor processing method of forming spacers of variable thickness, the method comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first protrusion comprising either P-type silicon or non-doped silicon and at least one second protrusion, provided that:

(1) when the first protrusion comprises P-type silicon then the second protrusion comprises either non-doped silicon or N-type silicon; and,

(2) when the first protrusion comprises non-doped silicon then the second protrusion comprises N-type silicon;

contacting the wafer surface with ozone and tetraethylorthosilicate wherein delivery of the ozone is pulsed on and off, and delivery of the ozone and the tetraethylorthosilicate is via a linear injector, whereby the first protrusion and the second protrusion are in intimate contact with the ozone and the tetraethylorthosilicate;

decomposing the tetraethylorthosilicate with the ozone to selectively deposit silicon oxide over the wafer surface and both the first protrusion and the second protrusion, whereby a greater thickness of silicon oxide is deposited on the first protrusion than on the second protrusion; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second protrusions provides a layer of variable thickness around the first protrusion and the second protrusion.

26. A semiconductor processing method of forming spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first protrusion comprising either P-type silicon or non-doped silicon and at least one second protrusion, provided that:

(1) when the first protrusion comprises P-type silicon, then the second protrusion comprises either non-doped silicon or N-type silicon; and,

(2) when the first protrusion comprises non-doped silicon, then the second protrusion comprises N-type silicon;

reacting ozone and TEOS at a temperature up to about 500° C and a pressure of at least about 10 torr wherein delivery of the ozone is pulsed on and off, and delivery of the ozone and the tetraethylorthosilicate is via a linear injector, to selectively deposit silicon oxide over the wafer surface and both the first protrusion and the second protrusion, whereby a greater thickness of silicon oxide is deposited on the first protrusion than on the second protrusion; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second protrusions provides a layer of variable thickness around the first protrusion and the second protrusion.

27. The method of Claim 26 wherein the reaction occurs at a temperature up to about 400°C.

28. The method of Claim 26 wherein the reaction occurs at a pressure of at least about 300 torr.

29. The method of claim 26 wherein the pulse duration is between 1-4 seconds.

30. The method of claim 26 wherein the pulse duration is about 1 second.

31. A semiconductor processing method of forming wordlines with spacers of variable thickness, the process comprising the steps of:

providing a silicon comprising substrate having a surface comprising at least one first wordline comprising P-type silicon and at least one second wordline comprising N-type silicon, the first and second wordlines being separated on the substrate;

contacting the substrate with ozone and tetraethylorthosilicate wherein delivery of the ozone is pulsed on and off, and delivery of the ozone and the tetraethylorthosilicate is via a linear injector, whereby the first wordline and the second wordline are in intimate contact with the ozone and the tetraethylorthosilicate;

reacting the ozone and the tetraethylorthosilicate to selectively deposit silicon oxide over the substrate surface and both the first wordline and the second wordline, whereby a greater thickness of silicon oxide is deposited on the first wordline than on the second wordline; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second wordlines provides a layer of variable thickness around the first wordline and the second wordline.

32. A semiconductor processing method of forming wordlines with spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first wordline comprising P-type silicon and at least one second wordline comprising N-type silicon:

reacting ozone and tetraethylorthosilicate at a temperature up to about 500° C and a pressure of at least about 10 torr wherein delivery of the ozone is pulsed on and off, and the ozone and the tetraethylorthosilicate are delivered via a linear injector, to selectively deposit silicon oxide over the wafer surface and both the first wordline and the second wordline, whereby a greater thickness of silicon oxide is deposited on the first wordline than on the second wordline; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second wordlines provides a layer of variable thickness around the first wordline and the second wordline.

33. The method of Claim 32 wherein the reaction occurs at a temperature up to about 400°C.

34. The method of Claim 32 wherein the reaction occurs at a pressure of at least about 300 torr.

35. The method of claim 32 wherein the ozone is pulsed at intervals between 1-4 seconds.

36. The method of claim 32 wherein the ozone is pulsed at intervals of about 1 second.

37. A semiconductor processing method of forming spacers of variable thickness, the method comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first conductive region comprising either P-type silicon or non-doped silicon and at least one second conductive region, provided that:

(1) when the first conductive region comprises P-type silicon, then the second conductive region comprises either non-doped silicon or N-type silicon; and,

(2) when the first conductive region comprises non-doped silicon, then the second conductive region comprises N-type silicon;

decomposing tetraethylorthosilicate with ozone to selectively deposit silicon oxide over the silicon surface and over both the first conductive region and the second conductive region, wherein delivery of the ozone and the tetraethylorthosilicate are alternately pulsed on and off, whereby a greater thickness of silicon oxide is deposited on the first conductive region than on the second conductive region and delivery of the ozone and the tetraethylorthosilicate is via a linear injector; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second conductive regions provides a layer of variable thickness around the first conductive region and the second conductive region.

38. The method of claim 37 wherein the pulse duration is between about 1 to about 4 seconds.

39. The method of claim 37 wherein the pulse duration is about 2 seconds.

40. A semiconductor processing method of forming spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first conductive region comprising either P-type silicon or non-doped silicon and at least one second conductive region, provided that:

(1) when the first conductive region comprises P-type silicon, then the second conductive region comprises either non-doped silicon or N-type silicon; and,

(2) when the first conductive region comprises non-doped silicon, then the second conductive region comprises N-type silicon;

contacting silicon-comprising substrate with ozone and tetraethylorthosilicate wherein the ozone delivery and the tetraethylorthosilicate are alternately pulsed on and off whereby the first conductive region and the second conductive region are in intimate contact with the ozone and the tetraethylorthosilicate and the delivery of the ozone and the tetraethylorthosilicate is via a linear injector;

reacting the ozone and the tetraethylorthosilicate at a temperature up to about 500° C and a pressure of at least about 10 torr to selectively deposit silicon oxide over the substrate surface and both the first conductive region and the second conductive region, whereby a greater thickness of silicon oxide is deposited on the first conductive region than on the second conductive region; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second conductive regions provides a layer of variable thickness around the first conductive region and the second conductive region.

41. The method of Claim 40 wherein the reaction occurs at a temperature up to about 400°C.

42. The method of Claim 40 wherein the reaction occurs at a pressure of at least about 300 torr.

43. The method of Claim 40 wherein the pulse duration is between 1-4 seconds.

44. The method of claim 40 wherein the pulse duration is about 2 seconds.

45. A semiconductor processing method of forming spacers of variable thickness, the method comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first protrusion comprising either P-type silicon or non-doped silicon and at least one second protrusion, provided that:

(1) when the first protrusion comprises P-type silicon then the second protrusion comprises either non-doped silicon or N-type silicon; and,

(2) when the first protrusion comprises non-doped silicon then the second protrusion comprises N-type silicon;

contacting the wafer surface with ozone and tetraethylorthosilicate wherein delivery of the ozone and the tetraethylorthosilicate are alternately pulsed on and off, and the delivery of the ozone and the tetraethylorthosilicate is via a linear injector, whereby the first protrusion and the second protrusion are in intimate contact with the ozone and the tetraethylorthosilicate;

decomposing the tetraethylorthosilicate with the ozone to selectively deposit silicon oxide over the wafer surface and both the first protrusion and the second protrusion, whereby a greater thickness of silicon oxide is deposited on the first protrusion than on the second protrusion; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second protrusions provides a layer of variable thickness around the first protrusion and the second protrusion.

46. A semiconductor processing method of forming spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first protrusion comprising either P-type silicon or non-doped silicon and at least one second protrusion, provided that:

(1) when the first protrusion comprises P-type silicon, then the second protrusion comprises either non-doped silicon or N-type silicon; and,

(2) when the first protrusion comprises non-doped silicon, then the second protrusion comprises N-type silicon;

reacting ozone and TEOS at a temperature up to about 500° C and a pressure of at least about 10 torr wherein delivery of the ozone and the tetraethylorthosilicate are alternately pulsed on and off, and delivery of the ozone and the tetraethylorthosilicate is via a linear injector, to selectively deposit silicon oxide over the wafer surface and both the first protrusion and the second protrusion, whereby a greater thickness of silicon oxide is deposited on the first protrusion than on the second protrusion; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second protrusions provides a layer of variable thickness around the first protrusion and the second protrusion.

47. The method of Claim 46 wherein the reaction occurs at a temperature up to about 400°C.

48. The method of Claim 46 wherein the reaction occurs at a pressure of at least about 300 torr.

49. The method of claim 46 wherein the pulse duration is between 1-4 seconds.

50. The method of claim 46 wherein the pulse duration is about 2 seconds.

51. A semiconductor processing method of forming wordlines with spacers of variable thickness, the process comprising the steps of:

providing a silicon comprising substrate having a surface comprising at least one first wordline comprising P-type silicon and at least one second wordline comprising N-type silicon, the first and second wordlines being separated on the substrate;

contacting the substrate with ozone and tetraethylorthosilicate wherein delivery of the ozone and the tetraethylorthosilicate are alternately pulsed on and off, and delivery of the ozone and the tetraethylorthosilicate is via a linear injector, whereby the first wordline and the second wordline are in intimate contact with the ozone and the tetraethylorthosilicate;

reacting the ozone and the tetraethylorthosilicate to selectively deposit silicon oxide over the substrate surface and both the first wordline and the second wordline, whereby a greater thickness of silicon oxide is deposited on the first wordline than on the second wordline; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second wordlines provides a layer of variable thickness around the first wordline and the second wordline.

52. A semiconductor processing method of forming wordlines with spacers of variable thickness, the process comprising the steps of:

providing a silicon-comprising substrate having a surface comprising at least one first wordline comprising P-type silicon and at least one second wordline comprising N-type silicon:

reacting ozone and tetraethylorthosilicate at a temperature up to about 500° C and a pressure of at least about 10 torr wherein delivery of the ozone and the tetraethylorthosilicate are alternately pulsed on and off, and the ozone and the tetraethylorthosilicate are delivered via a linear injector, to selectively deposit silicon oxide over the wafer surface and both the first wordline and the second wordline, whereby a greater thickness of silicon oxide is deposited on the first wordline than on the second wordline; and,

etching the silicon oxide deposited on the substrate to remove silicon oxide from the surface of the substrate, whereby the silicon oxide layers remaining on the first and second wordlines provides a layer of variable thickness around the first wordline and the second wordline.

53. The method of Claim 52 wherein the reaction occurs at a temperature up to about 400°C.

54. The method of Claim 52 wherein the reaction occurs at a pressure of at least about 300 torr.

55. The method of claim 52 wherein the ozone is pulsed at intervals between 1-4 seconds.

56. The method of claim 52 wherein the ozone is pulsed at intervals of about 2 seconds.